# The Alberta oil sands environmental research program
## an overview

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## AN OVERVIEW

by

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## INTRODUCTION

This paper departs somewhat from the air pollution theme of this conference, and is intended to provide an overview of the Alberta Oil Sands Environmental Research Program (AOSERP). At the outset, it should be emphasized that industry also operates substantial environmental research programs, which are described elsewhere.(1) No hard data are included in this paper; rather, an attempt is made to provide an integrated picture of how AOSERP was born, what it has done, and what use may be made of the data it has generated.

AOSERP was initiated in 1975, under a Federal-Provincial Agreement and funded jointly by Canada and Alberta. Originally the Program was intended to run for 10 years, with a budget of $4,000,000 per year. The Federal Government withdrew from the Program at the end of the fiscal year 1978, and the Alberta Government decided to fund the Program to its conclusion in 1980. The Program is now an operating division in the Alberta Department of Environment, and will be amalgamated with the Research Secretariat of Alberta Environment in 1980 to form a new Research Division for that department. It is to be expected that a sizable research effort will be maintained in the Athabasca Oil Sands region, but research activities likely also will spread to other areas of Alberta in future.

It should be emphasized that almost all the work carried out by AOSERP is extramural, split about evenly between private contractors and universities. In the initial stages of the Program, over 80 percent of the work was carried out "in house" by various government agencies. It has been the experience of program management in AOSERP that considerably greater flexibility, efficiency and cost effectiveness for research projects can be obtained by contracting out, rather than building another government system to carry out the research.

Interest in the Athabasca tar sands deposits has been a matter of record for almost 200 years, and is discussed in detail by Carrigy and Kramers.[2] Accelerated development of oil sands is closely related to the price of oil, and the present situation makes it reasonable to expect the construction of additional surface mines and extraction plants, as well as the development of so-called *in-situ* technology to exploit deposits which are too deep for the application of conventional surface mining techniques.

AOSERP is structured on the principle that environmental research can best be carried out using a systems approach. Consequently, the Program is operated under Air, Land, Water, and Human systems, each headed by a research manager, with a program director or chief administrative officer. All work is published with the Program expected to generate about 200 research reports in the five year period from 1975 to 1980. Structure, function, and operating policy are recorded in a policy document published in 1977.[3]

Because environmental data on the oil sands region were largely non-existent, first AOSERP efforts were concentrated on a review of what was available, plus identification of priority activities to fill the most important knowledge gaps. Since its inception, AOSERP has concentrated heavily on establishing data bases in the Air, Land, Water, and Human systems. The most extensive programs initially were to establish meteorological and air quality networks for the Air System, and hydrological and water quality networks for the Water System. A physical inventory was developed for the Land System emphasizing topography, surficial geology and soils and vegetation. Human System research is designed to identify significant changes in the human environment as a result of oil sands development, as well as to provide a reliable compendium of social statistics which can be used for making projections concerning future public policy decisions. The following sections will deal specifically with research in each of the four systems, and some general conclusions will be presented on the effectiveness of a program of the nature of AOSERP, as well as industry and government involvement in environmental research.

## AIR SYSTEM

Air System research in AOSERP was designed to take advantage of all available meteorological and climatological data gathered in the oil sands region during the past several decades. However, specific projects required design of direct application to the effects of oil sands development on air quality. Field projects were therefore developed by AOSERP which were intended to provide information on the processes involved in dispersion and deposition of airborne pollutants released from oil sands plants.

Because climate relates directly to all physical, chemical and biological processes in the environment, considerable attention has been devoted to gathering meteorological information on a continuous basis. Data on temperature, wind and precipitation are gathered at remote, solar charged, battery powered stations and transmitted by radio on an hourly basis 24 hours per day, where they are stored on computer tapes for later analysis and use.

An air quality network of 13 continuous monitors is also maintained through the joint efforts of AOSERP and industry, with over 100 total sulphate candles in operation. Sampling at selected sites is also carried out with high volume samplers to determine levels of atmospheric particulates. Both natural and anthropogenic (man-made) atmospheric constituents are measured. Because natural and anthropogenic atmospheric constituents may interact, data on air quality must be obtained on a long term basis, over large areas, and must as well reflect the meteorology of the region.[4]

Industrial plumes undergo chemical transformations with time, in response to insolation, temperature and levels of natural atmospheric constituents mentioned above. Air quality measurements must therefore be taken with regard both to meteorological conditions and plume chemistry and deposition processes.

At present, the Program has acquired sufficient air quality and meteorological data to establish the baseline conditions for the region. These conditions are on a synoptic scale, and further data are required before long rangeair quality management requirements can be predicted with precision.[5] Future Air System research will be discussed later, in a slightly different context.

## LAND SYSTEM

AOSERP Land System research has consisted largely of constructing reliable inventories, as mentioned earlier. Several divisions of the area can be made on the basis of significant differences in physiography, surficial geology and landform, as well as on soils and vegetation.

Direct affects of mining and extraction of bitumen are restricted to less than one percent of the total area of the region. Nevertheless, roads, movement of vehicles, boats and aircraft, pre-construction surveys, and leisure-time movement of several thousand people all contribute unknown effects. Terrestrial habitats have been mapped[6] and present levels of utilization of fish and wildlife resources have been determined.[7]

It is difficult to predict effects of oil sands development on terrestrial ecosystems. Air pollution is light, but it is persistent, and will require long range monitoring. Floral responses to emissions from oil sands plants will require the construction of several alternative scenarios, and will be discussed later, with future Air System research.

## WATER SYSTEM

Water System research has largely been confined to streams, because direct affects of oil sands development on lakes as yet appears unlikely. Streams have been assigned the higher priority because of the greater probability of direct effects from siltation as a result of land clearing, chemical effects of saline waters from mine depressurization and possible chemical pollution from tailings ponds.[8]

An extensive hydrological network has been established to provide flow data on the major tributary streams to the Athabasca River, and hydrogeological investigations have been carried out to document both the deep groundwater characteristics and the role of shallow groundwater in recharge of streams.[9]

Water quality research has now defined the most important chemical parameters both of surface and groundwater. A high degree of variability in water chemistry adds to the difficulty of interpretation of traditional water quality parameters. Chemical constituents change with season and stage of discharge for many streams, with

notable effects of surficial geology on the water chemistry of drainage basins. Because of the variable water chemistry, it is not simple to construct a water quality model or to define an adequate water quality monitoring program in relation to both natural and anthropogenic influences.[10]

Biological investigations in the earlier days of AOSERP concentrated heavily on fish, invertebrates and microbiota. Latterly, investigations have been turned toward primary productivity[11] and heterotrophic metabolism in streams. In general, streams of the area are highly productive, and likely are resistant to chemical pollution. However, a chemical model for streams has yet to be constructed which could be used as a predictive tool for water quality monitoring and management.

## HUMAN SYSTEM

Direction for AOSERP Human System research is predicated on the assumption that the human population of the region is in a state of flux, and that change in socio-economic characteristics will continue to change. Consequently, evaluation of present and probable future social conditions is required, in order to assess the present social impacts and the need for public programs to accommodate them.

Data are being accumulated which will allow quantification of changes in population, employment, and income. Studies of these changes have included a historical overview of socio-economic development of the region, assessment of service delivery systems, a study of the change in social conditions with time, assembly of a compendium of social statistics, impacts of construction camps, environmental health and others related directly to social impacts of oil sands development.[12] Human System research has been designed with two specific purposes: (1) to provide reliable baseline data for the oil sands region; and (2) to provide an integrative framework for maximizing the usefulness of Human System research in public policy decisions.

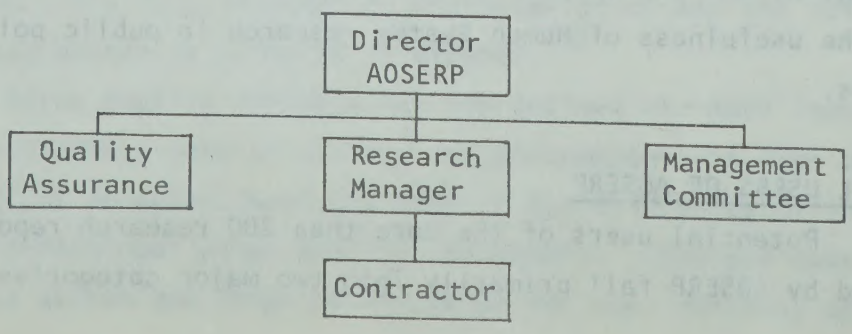
## POTENTIAL USERS OF AOSERP

Potential users of the more than 200 research reports generated by AOSERP fall primarily into two major categories:

(1) Government agencies; and oil sands corporations. Many of the research reports also contain basic information that can be of wide interest outside the region. Government agencies by and large now have sufficient data for most management decisions related to oil sands development. Industry has been responsible for work carried out on company leases, and presumably can meet the requirements of regulatory agencies by using both AOSERP data and that generated by their own efforts.

At present, widespread deleterious effects of oil sands developments cannot be documented. As mentioned earlier however, air pollution will persist over the life of developments in the region. While levels of air pollution are low enough that for the most part effects on trees cannot be detected,[13] the possible very long term effects cannot be predicted. Consequently, a terrestrial biomonitoring program has been designed to provide continuous assessment of the possible effects of air pollution.[14] The biomonitoring program has resulted from three workshops and consultations with scientists in Alberta, as well as in other parts of Canada and the United States. The program will involve a network of about 25 permanent sample plots in the oil sands region, including a number on operational oil sands leases. The network will involve both industry and government, under a co-operative research model developed by AOSERP with oil sands corporations.[15] A similar biomonitoring program is being developed for the Water System.

A model outlined below indicates the general operational structure for large AOSERP projects which may go on for more than one year. These projects involve such activities as the biomonitoring program discussed above, construction of an airshed management model, plus development of an aquatic biomonitoring program and watershed management model for the region.



The Quality Assurance aspect of the model is of very great importance. The Quality Assurance group will be comprised of three or four senior scientists in the discipline appropriate to the research, and will review terms of reference of the project in relation to research reports. The management committee will be comprised of the research manager and senior staff from users, such as government agencies and oil sands industry. Referees review the final research reports before publication. It has been the experience of AOSERP managers that the project model outlined develops a high degree of credibility for the Program.

Something should be said about the general usefulness of AOSERP. The Program has expended about $18.5 million since 1975. A very large amount of data has been generated, and all research reports have been published. As a general assessment, it can be stated that industry and government have available sufficient data to make rational judgements about the impacts of oil sands development on the biophysical resources of the region and the people who live in it.

It would be unwise to state that the picture of the environment in the oil sands region is complete. Certainly, both government and industry will have to carry out more research. It is safe to say, however, that the data gathered thus far is probably more extensive than that available for industrial developments in remote areas anywhere else in Canada and perhaps anywhere else in the world. Perhaps this is a reflection of the established policy of environmental legislation in Alberta which allows for the orderly development of resources with a minimum of environmental damage.

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